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GUIDELINES ON
RISK BASED INSPECTIONS FOR HULLS OF FLOATING OFFSHORE UNITS

MARCH 2024

Guidelines on Risk Based Inspections for Hulls of Floating Offshore Units

March 2024

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Foreword

Integrity management of offshore installations intended for Oil and Gas production activities is performed by recognizing and addressing the risks which such installations are exposed to throughout its service life. Classification Surveys for ships conventionally follow a prescriptive approach. However, for offshore installations, it may be preferable to develop Risk Based Inspection Plans (RBI) which are regularly updated taking into account the information obtained from such inspections.

Surveys of FOUs planned in accordance with application of risk based techniques is also indicated in Chapter 2, Section 1.2 of the *Rules and Regulations for the Construction and Classification of Offshore Floating Offshore Units*, (herein after referred to, as the FOU Rules). The RBI technique thus offers an alternative approach to asset operators/owners.

This document is intended to provide guidance to stakeholders such as designers, shipyards, asset operators/ owners on the development of RBI plans for FOUs.

Section 1

Introduction and Overview

1.1 Scope

1.1.1 These Guidelines are intended to address risk based inspection planning of the following hull structural components of FOUs (including, but not limited to):

a. Primary structure comprising of the outer hull, longitudinal strength members, watertight integrity members, transverse floors, longitudinal and transverse bulkheads including their stiffening arrangements
b. Turret compartment
c. Mooring system attachments on the hull structure
d. Pedestals and foundations including supports for topside modules

1.1.2 FOUs which comply with an approved RBI regime in accordance with these Guidelines will be assigned additional class notation, **RBI-HULL**.

1.2 Objective

1.2.1 The Guidelines are intended to clarify key elements in developing and updating risk-based inspection plans for FOU hull structure to designers, shipyards, and asset operators/ owners

1.2.2 The philosophy followed in these Guidelines is to identify and effectively manage risks during the lifetime of a FOU taking into account information during the design and construction phase, inspections during operational life of the FOU and make informed decisions to ensure that the structural integrity is adequately maintained.

1.3 Elements of an RBI Plan

1.3.1 The key elements which should be addressed within a RBI Plan are as follows (including, but not limited to):

a. Philosophy/ Approach for risk-based integrity management including the specification of acceptable risks
b. Identification of critical structural components/ members
c. Identification of failure modes contributing to loss of structural integrity (e.g. yield, ultimate strength, excess deformation, failure, fatigue & fracture etc.) or limit states (e.g. Ultimate Limit State, Serviceability Limit State, Fatigue Limit State etc.)
d. Identification of target probabilities of failure or target reliability indices
e. Identification of parameters contributing to the failure modes
f. Identification of the uncertainties/variability of the parameters
g. Structural integrity degradation models (based upon recognized/ accepted theories; e.g. fatigue crack growth, corrosion growth models, ultimate hull girder strength, buckling evaluation model etc.)
h. Prediction of time to loss of structural integrity/ failure for each critical structural component taking into account the uncertainties in the parameters contributing to the failure modes
i. Development of inspection plans to ensure that the target probabilities of failure are not exceeded for each critical structural component at any point during the service life. The inspection plan should address the following details for each critical structural component:

    i. **<u>What</u>** to inspect (e.g. particular structural component such as hopper knuckle connection)

ii. **Where** to inspect (exact location/detail, consideration should also be given to available means of accessing the location)
iii. **When** to inspect (intervals of inspection, e.g. every three years)
iv. **How** to inspect (inspection technique, e.g. close visual inspection, NDT etc. The inspection technique selected should also take into the POD (probability of detection) curves based upon the specific technique)

j. Remedial action to be taken in case damage is detected during the inspections
k. Updating of the RBI plans based upon the outcome of the inspections (e.g. crack detected/ not detected at a particular critical location or corrosion identified etc.)
l. Systematic collection, archival, storage and retrieval of data used during development and update of the RBI Plans

1.4 Integrity Management Team

1.4.1 The RBI Plan should be developed, maintained, implemented and updated by an Integrity Management Team (RBI Team) composed of experienced experts in all relevant domains/ topics pertaining to structural integrity of the FOU hull, such as the following:

.1 Structural integrity experts (strength evaluation experts, fatigue evaluation experts, corrosion evaluation experts etc.)
.2 Risk/ Reliability engineers
.3 Representatives in charge of operations of the FOU which may also include the offshore installation manager
.4 Health, Safety & Environment (HSE) experts from the operators' side
.5 Hull Surveyors, Underwater Inspectors, Divers etc
.6 Experts from the FOU designers' side
.7 Experts from the FOU builders' side
.8 Experts on corrosion protection systems (e.g. paint manufacturers, ICCP manufacturers
.9 Other relevant subject matter experts

1.4.2 A suitable team leader should be selected from the RBI team who would be responsible for the development, maintenance, implementation and periodic updating of the RBI plan.

1.4.4 The list of members in the RBI team with their brief CVs and experience should be submitted with the RBI plan. Any changes in the RBI team composition should be communicated to IRS.

1.5 RBI Process

1.5.1 The RBI plan is a 'dynamic' or a 'live' document. It is to be periodically reviewed and updated to consider the results of the inspections of the FOU hull and accordingly decide further actions as may be necessary.

1.5.2 The RBI Team should meet atleast once in a calendar year to discuss and deliberate the outcome of inspections of the FOU hull performed during that period.

1.5.3 A comprehensive review of the outcomes of inspection of the FOU hull is recommended to be undertaken by the RBI Team atleast once in 5 years. This review will enable evaluation of impact of recommendations from previous meetings, identification of updates (if necessary) to the initial/ updated RBI plan (e.g. consider effect of any abnormal degradation in the structural health (e.g. excessive corrosion wastage rate), consider all damages/ wear which have occurred in this period as to whether they exhibit a pattern which warrants further attention, include additional structural components to be inspected, more frequent inspection intervals or change in use of inspection techniques, take into account any change of management or risk management philosophies, take into account any new risks which may be incumbent on the FOU hull, delete obsolete risks (if any) etc.).

1.5.4 IRS Surveyor(s) should also be included to participate in such annual and five-yearly meetings. This is to enable IRS to confirm that the RBI plan is being implemented in a proper manner. IRS may suspend the RBI programme and revert to the normal periodical survey regime, as applicable for maintenance of Classification, if the inspections are not being performed in accordance with the approved RBI Plan or the RBI process is not being adhered to.,

1.6 Statutory and National Authority Requirements

1.6.1 RBI plans are a deviation from the normal schedule of periodical surveys followed in practice from Classification and Statutory point of view. The RBI plan should therefore clearly outline those items for which the periodic classification survey regime is to be applied.

1.6.2 RBI Plans are not to be used as an instrument to waive or replace surveys required by Statutory conventions such as SOLAS, MARPOL, ICLL, MODU Code or Regulations of the National Authority (in the coastal waters of whom the FOU is operated) etc.

1.6.3 The FOU owner/operator is solely responsible and advised to approach the Flag Administration and/or National Authorities (in the coastal waters of whom the FOU is operated) to seek and obtain necessary approvals/ permissions/ exemptions/ waivers for implementing the RBI Plan.

1.7 RBI Plans for FOUs not constructed under the survey of IRS

1.7.1 These Guidelines are applicable to new FOU units designed and constructed under the survey of IRS and in accordance with the FOU Rules. For FOU units converted from ships classed with IRS, the applicability of this document will be specially considered by IRS.

1.7.2 For existing FOUs transferred to IRS Class, the application of these Guidelines for preparation of RBI Plans will be specially considered. (This will depend upon the availability of all documentation and records available as regards the service history of the FOU so as to enable satisfactory confirmation of the structural health of the FOU at the time of transfer of class to IRS)

1.8 RBI Plans developed in accordance with other international/recognized standards

1.8.1 It is noted that International Standards are available for developing integrity management plans for floating structures. e.g. API RP 2FSIM. RBI plans developed and maintained in accordance with other recognized standards or guidelines by Classification Societies who are members of the International Association of Classification Societies (IACS) will be specially considered by IRS.

Section 2

RBI Plan Development

2.1 General

2.1.1 RBI plan development is normally carried out in the following steps:

a. Defining the scope and objectives of the RBI plan
b. Discretizing the hull into structural components
c. Identification and risk assessment of failure modes pertaining to structural integrity of each structural component (quantitative assessment is preferred to the extent practicable)
d. Development of initial Inspection strategy and initial inspection plans to ensure structural integrity through the life
e. Updating of the RBI Plan

2.1.2 RBI plan updating is to be carried out using the outcome of the inspections to determine whether the initial inspection strategy and plans are serving the desired purpose of maintenance of structural integrity and health of the hull. If the outcome from the inspections is adverse (e.g., defects, cracks, excessive corrosion etc. are detected), then the inspection strategy and plans need to be revised to ensure that the hull structural integrity and health is maintained. It is recommended not to relax the inspection strategy and inspection plans even if the outcome of the inspections is favourable (e.g., very low wastage, zero cracks and defects etc.)

2.1.3 The following sub-sections provide further details of each stage indicated above.

2.2 Defining the Scope and Objectives of the RBI Plan

2.2.1 The RBI plan should clearly identify and list those structural members which are to be considered for inspection. The list of structural members considered within the scope of the RBI plan should include critical structural members which are identified from the strength and fatigue analyses of the FOU hull. Past experience on FOUs of similar design and/or construction and operating in similar environments may also be utilized to identify the structural members.

2.2.2 It is recommended to apply the RBI plan for surveys of the structural members in completeness for all relevant structural members. If the RBI plan is selectively applied only to specific structural members then it should clearly specify the same. The RBI plan should further list those relevant members for which the survey methods and inspection intervals deviate from the periodical survey requirements in accordance with Chapter 2 of the FOU Rules. Appropriate justification should be provided for excluding particular structural members from the RBI plan.

2.2.3 The RBI plan should also identify the structural members which are mandatorily required to be surveyed in accordance with statutory instruments and confirm that surveys for these members will be in accordance with the statutory instruments. It is the responsibility of the Owner to obtain requisite approval from the Flag Administration of the FOU and/or the relevant National Authority (in whose waters the FOU is installed and operated) in case of any deviation of surveys of such structural members from the statutory survey requirements.

2.2.4 The RBI plan should clarify the interfaces to be considered. For e.g. the interface between the topside modules and topside module supports on deck, interface between turret compartment and turret buoy etc.

2.3 Description of the FOU functions and systems

2.3.1 The RBI plan should include a description of the FOU with its production modules and systems and support modules and systems. A brief description of the intended functions of each module and system is to be provided. The description should also include the general arrangement plan of the FOU hull and provide an overview of the various tanks, compartments, spaces, arrangements of sea-chests, details of corrosion protection systems etc. The envelope of operating and extreme environments anticipated during the FOU service life should also be elaborated. The purpose of the description is to aid the planners in holistically considering all aspects of the FOU.

2.4 Discretization of the Hull into structural components

2.4.1 The hull structure should be discretized into various structural components to facilitate development of the RBI plan. The aim of the hull structure discretization should be to specifically identify structural elements. The discretization should not be too coarse but also may not be too refined so as to create difficulties in practical implementation of the RBI plan.

As an example, the hull structure discretization can typically follow the high-level segregation as outlined below:

1. Outer hull
2. Cargo Oil Tanks (Tank no. 2, Tank no. 3 etc.)
3. Water Ballast Tanks (Tank no. 2, Tank no 3, etc.)
4. Slop Tank
5. Fuel Tanks
6. Methanol Tanks
7. Void Tanks
8. Turret Compartment (if applicable)
9. Machinery Space
10. Other tanks

The individual components should be further discretized. For example, for Cargo Oil Tank (e.g. Cargo Oil Tank No. 2), the following would be the key structural elements:

1. Tank boundaries (or longitudinal and transverse bulkheads)
    a. Longitudinal Bulkheads
    b. Transverse Bulkheads
    c. Double Bottom
    d. Main Deck
2. Girders
3. Stringers
4. Stiffeners and Faceplates for the primary members as indicated above
5. Interfaces (e.g., crane pedestals, supports for topside modules, mooring system attachments on hull, foundations for heavy equipment etc.)

The above individual components can be further segregated (e.g. between frames no. 54 to 55 or between elevation 24000 ABL to 27000 ABL etc.).

2.4.2 The detailed structural strength and fatigue analyses reports for the hull structure should also be taken into account to ensure that the locations with high utilization factors (e.g. η>0.8) are included in the RBI plan.

2.5 Risk Assessment

2.5.1 General

2.5.1.1 Risk assessment is necessary to identify critical areas of the hull along with their failure modes which pose risks to be mitigated and/or reduced to a tolerable extent. All areas of the hull should be considered in accordance with the discretization scheme indicated in Section 2.4.

2.5.1.2 Risk assessment may be performed using qualitative and/or quantitative techniques. Quantitative techniques are recommended to be utilized.

2.5.1.3 Available documentation with respect to the FOU design and construction is to be collected and reviewed. This documentation may include the following but may not be limited to:

- Layout of the facility
- Design brief and philosophy
- Operational profile of the FOU
- External environment to which the FOU is exposed
- Construction drawings of the FOU hull
- Structural design analyses and reports
    - Structural Strength (yield, buckling and ultimate strength)
    - Fatigue
- Construction and fabrication records
- Modifications/alterations in the hull construction from the approved drawings (if any)
- Risk management philosophy of the owner
- Risk acceptance criteria

2.5.2 Qualitative Risk Assessment

2.5.2.1 A Hazard Identification (HAZID) exercise should be performed. The purpose of this exercise is to ensure that all hazards pertaining to the hull components are identified and appropriately addressed by ensuring that anticipated precursors to the hazards with their respective failure modes are detected in a timely manner by provision of an appropriate inspection schedule. An example of template of a HAZID is provided in Appendix 1.

2.5.2.2 The HAZID should be performed by a team of qualified personnel. The team may include at least the following:

- Facilitator – having experience in risk assessment as well as familiar with marine operations
- Representatives of the Owner – having experience and knowledge as regards operations of the FOU during its design life
- Representatives of the Designer who participated in the process of hull design
- Representatives of the Shipyard/Builder who participated in the construction process
- Representatives of third party contractor (if applicable) who is tasked to perform hull inspections
- Representatives of IRS

The HAZID can also be performed by the Integrity management team as described in Section 1.4.

2.5.2.3 The process of hazard identification should consider the applicability of the following failure modes or deterioration mechanisms when evaluating susceptibility of the discretized hull structural areas:

- Yield
- Buckling
- Ultimate Strength
- Fatigue
- Fracture
- Excessive Corrosion

- Excessive Wear and Tear
- Excessive Deformation
- Leakage

2.5.2.4 The identified hazards should be evaluated for their likelihood of occurrence as well as their consequences with an aim to combine both these factors to obtain the risk. This may be accomplished by a qualitative approach by defining suitable frequency and consequence indices. The consequences should be considered from several perspectives (e.g. loss of life(s)/ serious injury(ies), loss/ damage to property, loss/ damage to environment etc.). Therefore, the risk also should be evaluated accordingly considering the various perspectives. The risk may be represented in the form of corresponding risk indices.

2.5.2.5 Risk acceptance criteria should be developed which are in line with the Owner's risk management philosophy and also in line with the best practices in the industry. The risk acceptance criteria should be used for ranking the hazards and identifying those hazards which are intolerable or those which need additional safeguards to arrive at a risk level which is tolerable.

2.5.2.6 Upon completion of the qualitative risk assessment the critical areas are to be identified along with the potential consequences of failure, conditions which affect the probability of failure and other relevant factors.

2.5.3 Structural Deterioration

2.5.3.1 The results of the qualitative risk assessment should be further used to establish inspection intervals for all areas/ locations/ structural elements considering the structural deterioration which would normally occur with time. Critical areas identified within the strength assessment, fatigue analysis reports and the construction monitoring plan (if any) should also be included within the list of areas for which structural deterioration is to be evaluated.

2.5.3.2 Quantitative approach of determining structural deterioration is recommended to be used. The effect of structural deterioration should take into consideration the following modes as a minimum:

- Hull girder failure (yield and ultimate)
- Ultimate strength/buckling failure of plate and stiffened panels
- Fatigue failure
- Leakage

2.5.3.3 The effect of uncertainties should be taken into account while evaluating structural deterioration. These uncertainties may manifest in different forms and are listed below but may not be limited to:

- Corrosion
- Environmental Loads
- Material Properties (e.g. tensile strength, ultimate strength, fatigue properties such as SN-curve, Fracture Mechanics properties etc.)
- Uncertainties arising from the use of a specific deterioration model (Model Uncertainties)
- Fabrication imperfections
- Dents/ Damages/ Deformations which have occurred during service
- Damage/ Failure criterion
- Other uncertainties as applicable

2.5.3.4 It is recommended to utilize the structural reliability-based approach(es) to evaluate the probability or likelihood of failure considering the deterioration mechanisms in 2.5.3.3. (Appendix 5 illustrates typical results from a strength reliability and fatigue reliability calculation)

2.5.3.5 Target structural reliabilities should be selected based upon the type of member (primary, secondary, tertiary). These should be in accordance with the risk acceptance criteria, as specified in 2.5.2.5

2.5.3.6 The inspection intervals should be determined taking into account the time for the particular structural deterioration mechanism to breach the target reliability.

2.5.3.7 Inspection techniques (e.g. close visual inspection or NDT (e.g. Ultrasonic Testing, Magnetic Particle, Dye-Penetrant test, Alternating Current Field Measurement (ACFM) etc.)) should also be recommended along with the inspection intervals for the considered areas/locations. The probability of detection (POD) of a flaw/ crack using a particular inspection technique should be taken into consideration.

2.5.3.8 Numerical techniques which may be used for evaluation can be referred from the listed References.

2.6 Submittal of the RBI Plan and Documentation

2.6.1 The RBI Plan and associated documentation should be submitted to IRS for review and approval. The documentation should consist of the following but may not be limited to:

- Description of the layout of the FOU
- Description of the functions and operational profile of the FOU
- Design brief of the FOU which includes the environmental conditions to which the FOU will be exposed
- Composition of the Integrity Management Team involved in development and updating of the RBI Plan (brief CVs should also be enclosed)
- Integrity management philosophy for the FOU
- Risk management policy of the Owner/Operator
- Discretization of the hull structural system into components
- Corrosion management
- Qualitative Risk Assessment
- Evaluation of the structural deterioration items in 2.5.3 (this should also include the assumptions, models used and the uncertainties considered along with limitations)
- Structural reliability calculations
- Selection of the target reliabilities used for the various structural deterioration mechanisms (this should be accompanied with appropriate justification)
- Development of the recommendations for inspection frequencies/ intervals along with the inspection method (Close visual inspection or NDT)
- Summary of the RBI plan for each hull structural element (this may be divided into the cargo region/non cargo region and further refined for each cargo hold or other tanks (water ballast, fuel, methanol, miscellaneous, void spaces etc.)
- Demarcation/deviations between RBI plan, Class survey requirements and requirements for surveys according to applicable statutory instruments (deviations should be accompanied by appropriate justifications. For deviations from statutory instruments, approval from the Flag Administration/National Authority is to be obtained by the Owner/Operator)

Refer Appendices 2 – 4 for sample templates regarding presentation of the outcome of the RBI plan development.

2.7 Management of Data/Information

2.7.1 Please refer Section 3.4.

Section 3

RBI Plan Updating and Management

3.1 General

3.1.1 As outlined in Section 1.5, the RBI plan is a 'dynamic' document. It is to be periodically updated taking into account results from the previous inspections. The periodic updating of the RBI plan is to be performed atleast once in every five years.

3.1.2 The aim of RBI plan updating is to take into account the fact that risks to the FOU hull are also dynamic in nature and may change over a period of time. Development of the initial RBI plan should be performed with clearly specified assumptions regarding the deterioration mechanisms and associated parameters. However, results from inspections/surveys provide additional information which may confirm or suggest need for changes to these mechanisms and associated parameters.

3.2 Collection of data/information from Inspections/Operations

3.2.1 The data obtained from inspections which may be normally considered for updating the RBI Plan are as follows (including, but not limited to):

a) Thickness measurements reports which facilitate computation of corrosion diminutions and rates
b) Survey reports indicating presence or absence of cracks, deformations or any other visible deterioration
c) Damage to the FOU from accidents (e.g. collision, dropped object etc.)
d) Maintenance/ repairs performed on the FOU
e) Damage/ wear and tear identified on areas of the FOU during scheduled inspections or non-scheduled inspections
f) Updates of detected damage or deterioration from other FOUs or similar vessels (especially if these FOUs and vessels are deployed in the same or similar fields)
g) Advances in technology for NDT (which may enable detection of smaller damages/defects)
h) Relevant data obtained from conversations with the crew/personnel during the inspections
i) Trends or patterns of damages (if identified)
j) Mitigation actions resulting from previous inspections and their outcomes

3.2.2 Data not obtained from inspections also may be relevant for updating the RBI plan. These are as follows (including, but not limited to):

a) Changes in operations(and associated parameters)
b) Changes in processes (and associated parameters)
c) Change in usage of tanks
d) Data obtained from continuous monitoring (e.g. FOU motions, wave data, wind data etc. for which instrumentation is fitted on the FOU or from other FOUs or units in the same field)
e) Data regarding any previous extreme environment events (e.g. hurricanes, cyclones etc.) since the last update of the RBI plan
f) Advances in knowledge/ understanding regarding deterioration mechanisms
g) Process upsets
h) Component failures
i) Structural modifications
j) Changes in lightship items and weights
k) Experience collected from the crew and personnel working on the FOU
l) Applicable changes in Statutory regulations/requirements
m) Management change
n) Other relevant data

3.3 Updating the Risk Assessment and RBI Plan

3.3.1 An update of the qualitative risk assessment should be performed using the collected data (as described in Section 3.2).

3.3.2. The update of the qualitative risk assessment should be preferably performed by the Integrity Management Team or the team of experts involved in the initial qualitative risk assessment. Members of the crew may also be included within the team performing the update.

3.3.3 If there has been a change in the risk management philosophy of the owner/operator then the risk acceptance criteria should also be identified. The target reliabilities for the structural reliability analyses for the structural deterioration mechanisms should also be re-evaluated.

3.3.4 The strength, fatigue and other failure modes of the FOU may be re-evaluated. For this purpose, it may be necessary to perform the associated structural strength analyses.

3.3.5 The information regarding detection of cracks (and whether or not they are subsequently repaired, measured crack size etc.), corrosion rate etc. should also be considered in the structural reliability analyses as regards evaluation of structural deterioration. Consequently, the structural reliability can be updated, and inspection intervals be re-evaluated to ensure that the structural reliability does not breach the target reliability limits.

Please see Appendix 5 which highlights the updating of reliability index based upon the outcome of inspection (Figure A.5.2)

3.3.6 Updates (if any) to the RBI plan should be submitted to IRS for approval.

3.4 Management of Data/Information

3.4.1 All data/ information utilized for development, updating and maintenance of RBI Plan should be stored securely on a secure digital platform by the Owner/ Operator for quick retrieval and reference as may become necessary. This aspect will be checked by IRS during the annual and quinquennial reviews of the RBI Plan

3.4.2 IRS should be provided access to the digital platform as indicated above.

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Appendix 1 – Sample Template for Qualitative Risk Assessment

Tank	Description	Damage Type	Possible Degradation Scenarios	Influencing factors for degradation	Safeguards Provided	Consequences	L	C	R	Notes/Remarks (may also include observations/pending notes from previous inspections)
WBT No. 3(P) **Deck**	Ballast Tank	STR	• Failure of coating (leading to excess corrosion)	• Relatively high hull girder stresses	• 2mm corrosion allowance considered in design • Deck coated with corrosion resistant paint • Deck	• Excess corrosion can lead to failure of deck	X	Y	Z	
…	…	FAT	• Fatigue cracking at the connection of the deck longitudinal stiffeners with the deck transverse members	• Relatively high fatigue stress range due to hull girder bending • Detail Design	• Fatigue life evaluation • Use of proper detail design • Inspection after completion of detail	• Cracks deteriorate the hull structure and contribute to degradation of strength	X1	Y1	Z1	…
…	…	…	…	…	…	…				…
Cargo Tank 4(C) **Bottom**	Cargo Tank	STR	• Tank Coating failure leading to excess wastage	• Coating system • Hull girder stresses •	• Anodes installed • Corrosion allowance considered •	• Loss of strength due to degradation	X3	Y3	Z3	
…	…	…	…	…	…	…				…
…	…	…	…	…	…	…				…
…	…	…	…	…	…	…				…

Note: X, Y, Z, X1, Y1 … are symbols. Actual values should be inserted based upon the method of evaluation.

Appendix 2 – Sample Template for RBI Plan Development

Tank	Risk	Location	Failure mode				Other Aspects			Inspection Interval	Remarks
			STR**		FAT**	LEAK	CM Location	Service History	Special Class Requirements		
			Plate	Stiff							
Cargo Tank 3©	X									4-6 years	
		Deck	>20	>20	29	N.A	Y				
		Bottom	>20	>20	26	Y					
		LBHD	>20	>20	32	Y					
		TBHD-A	>20	>20	23	Y	Y				
		TBHD-F	>20	>20	35	Y	Y				

** The entries under this column indicate the number of years taken to breach the threshold reliability level

Appendix 3 – Sample Template for RBI Plan

Tank	Location	Inspection Plan																			
		Year																			
		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
CT 1	Deck			GVI, TM						GVI, TM						GVI, TM					
	Bottom			GVI, GB						GVI, GB						GVI, GB					
	TBHD			GVI, CVI, EG, TM						GVI, CVI, EG, TM						GVI, CVI, EG, TM					
	LBHD			GVI, EG, TM						GVI, EG, TM						GVI, EG, TM					
	Inner Bottom			GVI, EG, AN, TM						GVI, EG, AN, TM						GVI, EG, AN, TM					
	Side Shell			GVI, GB						GVI, GB						GVI, GB					
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

GVI: General Visual Inspection
CVI: Close Up Visual Inspection
EG: Enhanced Gauging
AN: Anode Condition
TM: Thickness Measurement
GB: Girth Belt Thickness Measurement

Appendix 4 – Sample Tank Inspection Sheet

Item	Details
Tank	Cargo Tank No 1
Service of the Tank	Oil Storage
Planned Year and Month of Next Inspection	Before May 2025
Keyplan/General Layout of the Tank (also indicate if enhanced gauging is required to be performed)	

Location	**Items to be checked/recorded in the inspection**	**Trigger**		**Notes/Remarks**
		REQ	**FL**	
CM # 1 (DK)	CVI	**R**	**F**	As per RBI Plan
CM # 2 (BOT)	CVI	**R**	**S**	As per RBI Plan
CM#3 (TBHD)	CVI	**R**	**F**	As per RBI Plan
…	…	...	...	...
…	…	...	...	...
Deck	Thickness Gauging of plates and longitudinals	C	S,L	As per RBI schedule
	GVI of coating	C	S,L	Observe the coating and report any damage/anomalies
	GVI of stiffening arrangement below module supports	R	S,L	Observe the structures and report any damage/wastage/anomalies
	CVI of structure in way of manholes and hatches	R	S,F	Observe the structures and report any damage/wastage/anomalies
	CVI of structure in way of pipe penetrations	R	S	Observe the structures and report any damage/wastage/anomalies
	Overall GVI	C	S,F,L	Observe the structures and report any damage/wastage/anomalies
Inner Bottom	…	...	...	...
	…	...	...	...
	…	...	...	...
	…	...	...	...
	…	...	...	...
Transverse Bulkhead	…	...	...	...
.	.			
Enhanced Gauging	As per RBI Plan conduct the thickness measurements across the entire girth belt of the tank	R	S/L	As per RBI plan conduct enhanced gauging

Legend:

C: Class
R: RBI Plan
St: Statutory
F: Fatigue
S: Strength
L: Leak
GVI: General Visual Inspection
CVI: Close up Visual Inspection
NDT: Non-destructive testing (also specify the type e.g. UT, DP, MPI, ACFM etc.))

Appendix 5 – Sample Illustrations of Structural Reliability based Calculations

Strength Reliability

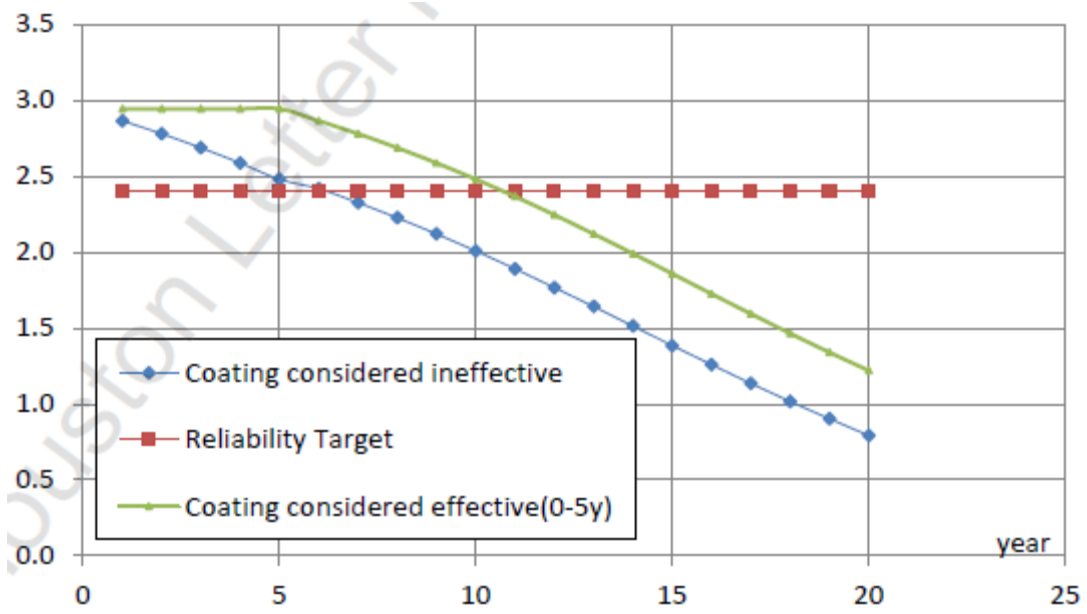

Figure A.5.1: Illustration of the evaluation of Strength Reliability (Yield Failure mode) for a CM (Condition Monitoring location)

Fatigue Reliability

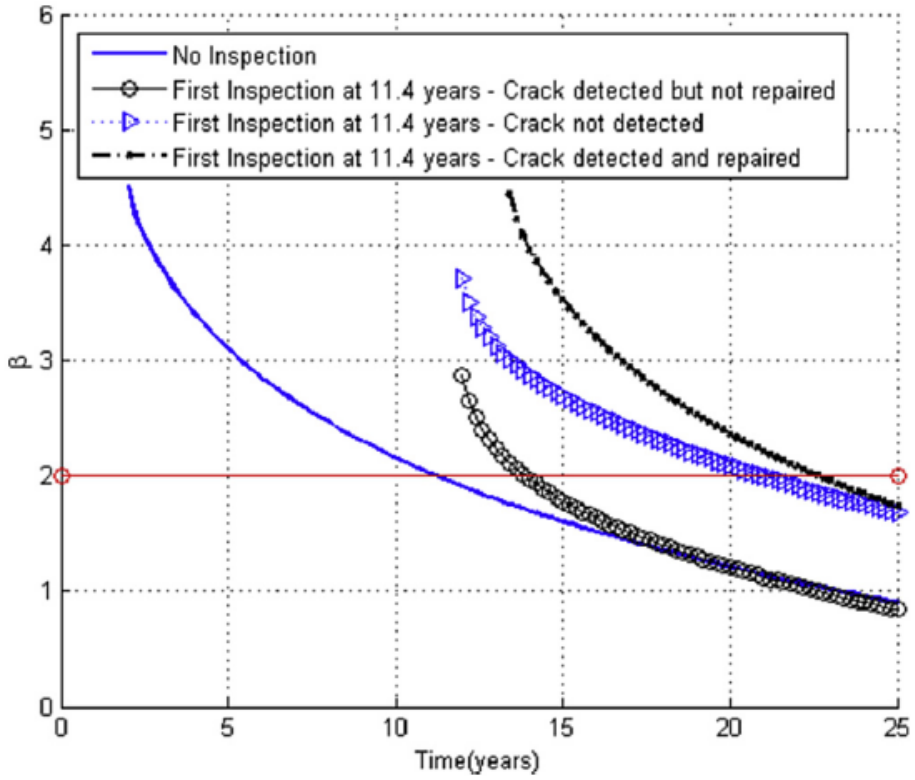

Figure A.5.2. – Illustration of the evaluation of the fatigue reliability (plot of reliability index vs service life) considering possible outcomes (apriori) of the inspection of a longitudinal stiffer – transverse webframe connection (without inspection, the reliability index drops below 2.0 at 11.4 years – This does not necessarily imply failure but indicates that the probability of failure has exceeded a threshold limit) (Note: NDT Inspection technique is considered in the above plot)

End of Guidelines